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INFORMATION CIRCULAR

MARKETING LITHIUM MINERALS

BY

LAWRENCE G. HOUK

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MARKETING LITHIUM MINERALS[1/]

By Lawrence G. Houk[2/]

INTRODUCTION

Lithium is the lightest of all metals, but as it deteriorates rapidly in air it has no structural applications. Alloys of lithium that will float upon water can be made with other light metals, but these ultralight alloys are not useful in aircraft production or elsewhere at present. Alone or alloyed with alkaline earth metals, lithium acts as a refining agent on molten metals, and as a minor constituent with other metals it imparts characteristic properties to the alloy. Lithium compounds have a somewhat wider application in commerce than either the metal or the alloys. They are used in the glass, ceramic, chemical, and air-conditioning industries and less extensively in the optical, pharmaceutical, electrical, and textile industries.

The United States is the leading producer and consumer of lithium ores and compounds and apparently has the largest known ore reserves. The value of lithium ores and primary chemical byproducts produced is relatively small, yet the lithium chemical industry yields products worth hundreds of thousands of dollars each year, owing partly to the high degree of purity demanded by the trade for most finished products and to the low combining weight of lithium. Fortunately, the low-grade ores can now be concentrated economically, and this fact, together with our extensive reserves, assures adequate supplies to meet any reasonable increase in demand. Lithium is listed as essential by both the American and British war agencies, and its military importance may be greatly enhanced.

Lithium Minerals

Spodumene, amblygonite, and lepidolite are the principal commercial lithium minerals, but the following six minerals may all be classified as ores of lithium.[3/]

1/ The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used. "Reprinted from Bureau of Mines Information Circular 7225."

2/ Associate mineral economist, Nonmetal Economics Division, Bureau of Mines.

3/ Schaller, W. T., Lithium Minerals: Industrial Minerals and Rocks, Am. Inst. Min. and Met. Eng., 1937, p. 427.

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Mineral	Simplified formula	Li_2O content, commercial range percent
Spodumene	Li Al Si_2 O_6	4 - 8
Amblygonite	Li Al F PO_4	8 - 9
Lepidolite	Li $KAl_2F_2Si_3O_9$	2 - 4
Triphylite	Li Fe PO_4	2 - 6
Petalite	Li Al Si_4 O_{10}	2 - 4
Zinnwaldite	Li K Fe Al_2 F2 Si_3O_{10}	2 - 3

Well over a hundred other minerals contain a small percentage of lithium.

Spodumene is the chief mineral source of lithium metal and its compounds. It occurs in pegmatites as large crystals or disseminated. The color generally is dull-gray to greenish-white, the hardness is 6.5 to 7.0, and the specific gravity is 3.17.

Amblygonite, a fluophosphate of lithium and aluminum, is the highest-grade ore of lithium. It is generally white and resembles white feldspar. Its cleavages, one perfect and the second imperfect, which intersect at a 74° angle, add to the similarity, but its ready fusibility and flame test easily distinguish it from any feldspar.

Lepidolite (lithia mica) may be almost white, gray, pink, purple, or blue, with hardness 3 and specific gravity 2.85. It commonly occurs as a pink to purple aggregate of micaceous scales or plates only a fraction of an inch in diameter.

Triphylite is a phosphate of iron and lithium containing some manganese. Its color ranges from gray to brown, hardness 5, and specific gravity 3.5.

Petalite, another silicate of lithium and aluminum, is generally massive, either white or gray, and has laminated cleavage.

Zinnwaldite, a lithia mica, contains about 10 percent iron and is similar to lepidolite except for color, which is brown, yellow, or dark gray.

Lithium ores are somewhat variable in composition, but the following analyses are typical:

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Typical analyses of the principal commercial lithium minerals, percent[4/]

	Spodumene	Lepidolite	Amblygonite
Silica (SiO_2)	64	51	--
Alumina (Al_2O_3)	27	27	34
Lithia (Li_2O)	7	4	9
Potash (K_2O)	--	11	--
Phosphoric acid (P_2O_5)	--	--	48
Water (H_2O) combined	--	2	5
Fluorine (F)	--	7	5
Iron, manganese, lime, magnesia, soda	2	1	1
Less oxygen equivalent of fluorine	--	3	2
	100	100	100

Test for Lithium

As fusible lithium minerals color the flame a bright crimson, the flame-test method generally is used to detect the presence of lithium in minerals and compounds. The crimson color of the flame is not as persistent as that of strontium. A few drops of barium chloride added to a lithium salt in solution and tested in a flame give, first, the crimson of lithium, then the green of barium, and finally, if strontium is present, the red of strontium. Lithium minerals do not become alkaline upon ignition, as do the strontium minerals. Powdered gypsum is added to the silicates before testing.[5/]

Occurrence

Lithium minerals usually are found in pegmatites; lithium is also present in brines, springs, sea water, plant remains, and meteorites.

The best-known source of spodumene is the Etta mine, Pennington County, in the Black Hills of South Dakota, where crystals up to 47 feet in length and 3 to 4 feet in diameter are found. In cross section the crystals may be square, rounded, or flat and exhibit perfect prismatic cleavage. The Tin Mountain mine, Custer County, has yielded spodumene from this same lithia-bearing province in the Black Hills. Disseminated spodumene occurs over a large area near Kings Mountain, Cleveland County, N. C., and in the northern section of the Black Hills in South Dakota. It has also been noted near Warren Station, Knox County, Maine, and in Massachusetts and Connecticut.

In lithium-bearing pegmatites lepidolite commonly segregates in the central portion. The Ingersoll mine near Keyston, S. Dak., has recently been the

4/ Schaller, W. T., Lithium Minerals: Mineral Resources of the United States, 1916; Part II, Nonmetals. U. S. Geol. Survey, 1919, pp. 8-12.

5/ Krause, E. H., Hunt, W. F., and Ramsdell, L. S., Mineralogy: McGraw-Hill Book Co., Inc., New York., 1936, p. 218.

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chief domestic producer, but in past years lepidolite has been produced in quantity at the Stewart mine at Pala, San Diego County, Calif., and the Harding mine, Taos County, N. Mex. It occurs near Ohio City, Gunnison County, and in Fremont County, Colo., and in Maine, Massachusetts, Connecticut, and Wyoming.

Amblygonite occurs associated with quartz, feldspar, and tourmaline in pegmatites. It is the most valuable ore of lithium; occurrences are rather widespread, usually in small amounts in the Black Hills of South Dakota, less extensively in San Diego County, Calif., and it is reported from Colorado and Wyoming.

Triphylite in small amounts accompanies other lithium minerals in pegmatites in the Black Hills. It is commonly massive and rarely in coarse crystals.

Petalite is a rare mineral found nowhere in commercial amounts except on the Island of Uto, Sweden, although it has been identified in samples from the Black Hills of South Dakota and in Wyoming.

Zinnwaldite occurs in veins and greisens and is found in Maine, Missouri, and Virginia.

Crude lithium sodium phosphate is recovered in substantial quantities from Searles Lake, Calif. The crude brines contain as much as 0.032 percent LiCl.[6/] Small quantities of lithium are present in a few mineral springs, the waters of which may be used for beverage or medicinal purposes; but many so-called lithia waters contain little or no lithia; others are artificially fortified with lithium salts.

Technology

Most lithium ores are mined selectively from workings at or near the surface and are brought to commercial grade by hand sorting. Where the lithium minerals (especially spodumene) are intimately associated with quartz and feldspar in minute particles, other methods of concentration are necessary. Spodumene ores from North Carolina and South Dakota have been concentrated successfully by froth flotation.[7/] The degree of weathering affects the flotability of the various minerals, but if the crushed ore is first agitated vigorously in a solution of sodium hydroxide, a clean separation can be made. Either a high-grade spodumene concentrate or a mixture of spodumene and feldspar (lithia spar) is possible with this method.

6/ Teeple, John E., Industrial Development of Searles Lake Brines: Am. Chem. Soc. Mono. 49, 1929, p. 18.

7/ Norman, James, and Gieseke, E. W., Beneficiation of Spodumene Rock by Froth Flotation' Am. Inst. Min. and Met. Eng. Tech. Pub. 1161, 1940.

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Lithium chloride may be obtained directly by heating spodumene with a calculated quantity of lime and calcium chloride. Another chlorination process yields portland-cement clinker and lithium chloride fume, which is recovered in a Cottrell precipitator.[8] Lepidolite has been successfully chlorinated by treatment with gaseous hydrogen chloride at about 935°C. for 13 hours.[9]

Uses

Lithium and its minerals and compounds have many and varied uses in industry, both actual and potential. The more important are in the glass, ceramic, chemical, air-conditioning, and metallurgical industries and less extensively in the electrical, pharmaceutical, and optical industries. In glass, lepidolite reduces the viscosity of the melt, decreases the coefficient of expansion, produces a harder surface, and increases the strength of the product.[10] Lithium carbonate also is used for this purpose. "Gertan," a lithium-beryllium-borate glass, is transparent to ultraviolet and X-ray. The carbonate is a powerful flux. It effectively increases resistance to thermal and electrical shock. In enamels and glazes it reduces the maturing temperature, increases the fluidity, and improves the quality.[11] Spodumene-feldspar mixtures have fusing points as low as 1,080°C., the best melting mixtures being within the following limits of composition.[12]

	Maximum, percent	Minimum, percent
Spodumene	35	15
Potash feldspar	50	25
Soda feldspar	50	20

Or, expressed in terms of chemical constituents as calculated from the above analyses:

	Maximum, percent	Minimum, percent
Li_2O	2.5	1.1
K_2O	6.2	3.2
Na_2O	5.1	3.2

8/ Fraas, Foster, and Ralston, Oliver C., Chloride Volatilization of Lithium from Spodumene: Bureau of Mines Rept. of Investigations 3344, 1937, 11 pp.
9/ Lof, Geo., and Lewis, Warren K., Lithium Chloride from Lepidolite: Ind. Eng. Chem., vol. 34, No. 2, February 1942, pp. 209-216.
10/ Ladoo, Raymond B., Nonmetallic Minerals: New York, 1925, p. 322.
11/ Betz, Geo. C., Lithium Minerals and Compounds in Ceramics: Jour. Am. Ceram. Soc., vol. 21, 1938, pp. 189-191.
12/ Boyd, J. E., Pyrometric Properties of Spodumene-Feldspar Mixtures: Jour. Am. Ceram. Soc., vol. 21, No. 11, November 1928, pp. 385-388.

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The chemical industry processes all the lithium ores and compounds except some of the ores used directly in the glass and ceramic industries. The list of lithium salts includes lithium acetate, benzoate, bitartrate, bromide, carbonate, chloride, chromate, citrate, fluoride, hydroxide, nitrate, oxalate, phosphate, stearate, and sulfate. A saturated solution of lithium chloride removes humidity, objectionable odors, and dust from the air and is used in air-conditioning and industrial drying plants.13/ It is also successfully used in dehydration of the air in blast-furnace operations. Heat-treating or carburizing furnaces utilize lithium vapor to neutralize the atmosphere within the furnace. Formerly lithium carbonate and citrate were used in considerable quantities in lithiated waters and diuretic preparations, but these medicinal uses are now small. However, the use of lithium compounds in soft drinks is reasonably large. The hydroxide increases the capacity and maintains the consistency of Edison-type storage batteries. In electrical welding of aluminum and magnesium and their alloys lithium chloride or lithium fluoride is usually employed in the flux. Lithium stearate is becoming important in lubricants.

Lithium as a minor alloying constituent with other metals imparts characteristic properties to the alloys. Probably the best-known is Bahnmetal, a lead-lithium alloy. The small amount of lithium present, (0.04 percent) adds to the hardness at high temperatures, increases its resistance to deformation, and imparts a fine grain and excellent wearing quality. The German National Railroad is said to use it as a bearing alloy on its rolling stock. However, it has never proved commercially successful in the United States. A lead-lithium cable sheathing containing 0.002 to 0.01 percent lithium has been patented in this country but has not yet found practical use.

An alloy of aluminum (scleron) containing 83 percent aluminum, 12 percent zinc, 2 percent copper, 0.5 to 1.0 percent maganese, 0.5 percent iron, 0.05 percent silicon, and 0.1 percent lithium is said to be superior to duraluminum in tensile strength, elastic properties, and hardness.

Lithium, when alloyed with magnesium to the extent of 0.05 percent, increases the tensile strength 10,000 pounds per square inch and increases the hardness and resistance to corrosion. Alloys of beryllium and lithium of low specific gravity (1.0 to 1.5) have been proposed for aircraft structures, but it is doubtful if they will prove useful in this capacity.

The great affinity of lithium for nitrogen, hydrogen, oxygen, sulfur, phosphorus, oxidized carbon, and silicates explains its efficient scavenging action on molten metal. Moreover, it forms stable nonmetallic compounds of low specific gravity or gases that are eliminated at pouring temperatures.

13/ Bichowsky, F. R., and Kelley, G. A., Concentrated Solutions in Air-conditioning: Ind. Eng. Chem., vol. 27, August 1935, pp. 879-882.

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The lithium is generally added to the melt in the form of a 50-50 lithium-calcium alloy or as an alloy of 98 percent copper and 2 percent lithium. Such alloys are said to be more effective than either metallic calcium or lithium alone.

Lithium-treated copper, which is oxygen-free and high in density and conductivity, is being produced on a commercial scale, but very little of the lithium is retained in the copper. In high-strength, high-conductivity bronzes, lithium is being used commercially as a refiner and deoxidizer with resulting increased conductivity.14/ In copper-chrome-lithium alloys for castings to carry current, the lithium alloy serves as a deoxidizer and degasifier, eliminates the chromium oxide, assures cleaner castings, and permits complicated thin-wall coring. Twice as much lithium alloy was used in treating copper castings in 1941 as in 1940. As lithium forms no alloys with metals of the iron group, its action on cast iron and steel is purely cleansing. Lithium-calcium alloy added to cast iron before pouring acts as a scavenger and increases the fluidity of the melt, thus producing a dense, sound casting. Although this casting is relatively hard, it can be machined easily because of its uniform texture and the absence of hard spots. In high-carbon steels lithium-calcium alloy acts as a refiner, and on stainless-steel alloys it is said to increase the resistance to corrosion and improve the polishing qualities.15/

An unusual use for lithium is to transport hydrogen. Four and one-half pounds of lithium hydride contains as much hydrogen as a filled steel cylinder of hydrogen weighing 180 pounds. In nitrogen fixation, lithium-treated copper electrodes reduce the voltage required and increase the yield of nitric oxide. The decided affinity of lithium for nitrogen is the property utilized in purification of helium.

The production of synthetic lithium fluoride crystals for optical lenses promises to extend the horizon in microscopic research. These crystals can transmit wider bands of light waves (from higher in the infrared to lower in the ultraviolet band) and refract different colors more equally than any other optical material.16/

Fused lithium nitrate in contact with soda glass at 500°C. for a 2- to 4-minute period will produce an effective etching. However, the lithium ions replace the sodium, producing molecular cracks and a porous structure, which appears to weaken the glassware.17/

14/ Osborg, Hans, Lithium--Theoretical Studies and Practical Application: Electrochemical Soc., New York, 1935, 68 pp.

15/ Osborg, Hans, Work cited, p. 46.

16/ Industrial and Engineering Chemistry, Crystals of Research, vol. 16, No. 21, November 10, 1938, p. 584.

17/ Kreidl, N. J., Fluxing Properties of Lithia: Foote Prints, June 1941, p. 10.

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Other uses for lithium compounds include application of the acetate, chromate, and oxalate to delustering fabrics, especially rayon; the borate as an ingredient of dental cements; the carbonate for treating citrus fruits to prevent decay, in making synthetic emeralds and aquamarines, and in the manufacture of luminous paints; the hydroxide for mercerizing sulfate cellulose; the iodide and bromide in making photographic papers; the nitride for curing meats, especially ham and frankfurters; the selenide in insecticides; and the nitrate in pyrotechnics.

Domestic Production

Domestic production of lithium began in 1898 in South Dakota, and of the total output of American mines, aggregating about 77,000 tons valued at $1,400,000 to 1940, inclusive, South Dakota and California each supplied about 40 percent, and New Mexico most of the remainder. Production by years, beginning with 1910, is indicated in the following table.

TABLE 1. - Lithium minerals produced and shipped in United States, 1910-41

	Short tons	Value	Average value per ton
1910	238	$2,380	$10.00
1911	500	9,000	18.00
1912	360	6,800	18.90
1913	530	14,900	28.10
1914	525	8,000	15.24
1915	486	9,867	20.31
1916	619	12,035	19.44
1917	2,062	42,912	20.80
1918	5,892	111,600	19.52
1919	6,287	115,000	18.30
1920	11,696	173,002	14.80
1921	1,833	33,508	18.30
1922	2,192	41,300	18.35
1923	2,310	38,800	16.80
1924	2,996	62,391	20.83
1925	3,140	58,500	18.64
1926	3,700	53,400	14.44
1927	4,173	59,656	14.30
1928	4,600	94,750	20.58
1929	(1/)	(1/)	(1/)
1930	1,797	56,327	31.30
1931	(1/)	(1/)	(1/)
1932	(1/)	(1/)	(1/)

1/ See footnote page 9.

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TABLE 1. - Lithium minerals produced and shipped in United States, 1910-41 (con'd)

	Short tons	Value	Average value per ton
1933	504	$12,997	25.75
1934	719	20,980	29.18
1935	1,154	26,834	23.25
1936	1,241	34,273	27.62
1937	1,357	36,206	26.55
1938	2/ 892	47,088	52.78
1939	2/1,990	97,000	48.75
1940	2/1,961	79,679	40.65
1941	2/3,832	115,718	30.20

1/ Not available.
2/ Includes dilithium sodium phosphate recovered from Searles Lake brines.

It is impossible to segregate the production figures as to types of ore, but it is estimated that of the total tonnage spodumene accounts for about 30 percent, amblygonite 10 percent, and lepidolite 60 percent. Most of the spodumene has come from South Dakota, although small quantities have been shipped recently from North Carolina. California and New Mexico formerly supplied most of the lepidolite, but in later years most of it has come from the Ingersoll mine in South Dakota.

The dilithium sodium phosphate (Li_2NaPO_4) recovered from the brines of Searles Lake first came on the market in 1938. As the lithium oxide content of these compounds may reach 20 percent, their high value distorts the per-ton value of lithium compounds shipped in 1938 and later years, as shown in table 1. This source has provided nearly half the raw lithium product needed for refined lithium salts in recent years.

World Production

The United States produces more than 50 percent of the world output of lithium ores. South-West Africa, Australia, Sweden, and Germany produce most of the remainder, and Canada, Portugal, Southern Rhodesia, and Spain contribute minor quantities. Commercial lithium deposits have been reported in India, Brazil, Madagascar, and Russia. Outside of the United States, Germany is the principal consumer. The zinnwaldite of Bohemia and Saxony were utilized before 1927 in making lithium alloy metal for use in bearing metal and a hard aluminum alloy, "scleron."

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Markets and Prices

The greater part of lithium-ore production never enters the open market. The chemical manufacturer owns his mines, the glass manufacturer contracts for his needs, and additional demands are restricted and intermittent. Independent mining operations, therefore, are small and sporadic, and the small operators just coming into production find it difficult to guarantee a definite tonnage and quality of ore, yet this they must do to obtain an assured market. Virtually the only method for prospective producers to learn what they can get for their ore is by direct negotiation with buyers. Trade-journal quotations for the various ores are nominal values based upon previous sales of all grades.

For spodumene, a recent quotation (January 29, 1942) in Engineering and Mining Journal Metal and Mineral Markets was "per unit Li_2O content, $5 on 6 percent grade, carload lots, North Carolina." This means that spodumene containing not less than 6 percent lithia and not too much iron, quartz, or tourmaline will net $30 per ton in carload lots in North Carolina.

Amblygonite 8 to 9 percent Li_2O was quoted early in 1942 at $40 "per ton f.o.b. mine." Some commercial requirements specify a minimum of 8 percent lithia; others, 6 to 7 percent. A large consumer pays $40 f.o.b. Custer, S. Dak., for 8 percent Li_2O and $1 per ton plus or minus for each 1/10 percent above or below 8 percent.

Lepidolite was quoted as of January 29, 1942, "per ton $24 and $25 for ordinary grade (3 percent), lump, f.o.b. mine." Lepidolite for the glass industry must have a low iron content, not exceeding 0.05 percent ferric oxide, a low tourmaline content, and be ground to pass 40-mesh or any size required by the purchasers. Indicative of the various grades of lepidolite formerly marketed, below are tabulated the grades of ore shipped from the Harding mine, Taos County, N. Mex., to Wheeling, W. Va., for use in the glass and pottery industry in 1924.18/

1. Clean lepidolite plus 10 percent spodumene, about 3 percent lithia.
2. 30 percent spodumene, 60 percent lepidolite, 10 percent quartz, up to 3.5 percent lithia.
3. 30 percent spodumene, 50 percent lepidolite, 10 percent quartz, 10 percent feldspar, about 3 percent lithia.
4. One-third each of lepidolite, spodumene, and microcline free from quartz, about 3 percent lithia.
5. Mixed albite and spodumene with about 10 percent lepidolite: nearly free of quartz, about 3 percent lithia.
6. Spodumene free of both quartz and lepidolite.
7. Spodumene with not over 10 percent quartz and lepidolite.

18/ Roos, Alford, Mining Lepidolite in New Mexico: Eng. and Min. Jour., 1926, p. 1039.

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All grades except 6 and 7 and probably 5 contained about 2 percent fluorine. Lumps were required to have a diameter less than 9 inches, and all grades must have low iron content.

Listed below are the prices of metallic lithium and lithium ores from 1926 to 1941.

TABLE 2. - Lithium and lithium ores[1/]

	Metallic lithium[2/]	Amblygonite[3/]	Lepidolite[4/]	Spodumene[5/]
Dec. 1925	$65.00	$50-60	$20-30	$20-30
July 1926	65.00	50-60	20-30	20-30
Dec. 1926	65.00	50-60	20-30	20-30
July 1927	65.00	50-60	20-30	20-30
Dec. 1927	24.80	50-60	20-30	20-30
July 1928	7/80.00	50-60	20-30	20-30
Dec. 1928	7/80.00	50-60	20-30	20-30
July 1929	7/80.00	50-60	20-30	20-30
Dec. 1929	7/96.00	50-60	20-30	20-30
July 1930	18.00	50-60	20-30	20-30
Dec. 1930	6/	50-60	50-60	50-60
July 1931	6/	50-60	50-60	50-60
Dec. 1931	18.00	50-60	50-55	6/
July 1932	15.00	50-60	50-55	6/
Dec. 1932	15.00	50-60	50-55	6/
July 1933	15.00	34-35	20-25	6/
Dec. 1933	15.00	34-35	20-25	6/
July 1934	15.00	34-35	20-25	6/
Dec. 1934	15.00	34-35	20-25	6/
July 1935	15.00	34-35	20-25	6/
Dec. 1935	15.00	34-35	20-25	6/
July 1936	15.00	34-35	20-25	6/
Dec. 1936	15.00	34-35	20-25	6/
July 1937	15.00	34-35	20-25	6/
Dec. 1937	15.00	34-35	20-25	5.00
July 1938	15.00	34-35	20-25	5.00
Dec. 1938	15.00	35-40	20-25	5.00
July 1939	15.00	35-40	20-25	5.00
Dec. 1939	15.00	40.00	22-25	5.00
July 1940	15.00	40.00	24-25	5.00
Dec. 1940	15.00	40.00	24-25	5.00
July 1941	15.00	40.00	24-25	5.00
Dec. 1941	15.00	40.00	24-25	5.00

See footnotes on following page.

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FOOTNOTES FOR TABLE 2.

1/ Compiled from Engineering and Mining Journal Metal and Mineral Markets.
2/ Per pound in 2- to 6-pound lots until October, 1931; thereafter in 100-pound lots, 98 and 99 percent.
3/ Per ton, 8-9 percent Li_2O, f.o.b. mine.
4/ Per ton ordinary grade, lump, f.o.b. mine.
5/ Per ton nominal until October 1937, thereafter spodumene per unit Li_2O contained 5 on 6 percent grade, carload lots North Carolina.
6/ Not quoted.
7/ Calculated from per-ounce quotation.

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The following are prices of lithium compounds.

TABLE 3. - Prices[1/] of lithium compounds

Date	Lithium bromide per lb., 100 lb. bbl.	Lithium carbonate per lb., 250 lb. bbl.	Lithium chloride per lb., 25 lb. jars	Lithium fluoride per lb., bbl.
July 1926	(2/)	$1.50	(2/)	(2/)
December 1926	(2/)	1.50	(2/)	(2/)
July 1929	$1.85	1.50	(2/)	(2/)
January 1930	1.85	1.50	(2/)	(2/)
July 1930	1.80	1.35	(2/)	(2/)
December 1930	1.80	1.35	(2/)	(2/)
April 1932	1.60	1.25	(2/)	(2/)
January 1933	1.60	1.25	(2/)	(2/)
July 1933	1.60	1.25	(2/)	(2/)
January 1934	1.60	1.25	(2/)	(2/)
July 1934	1.70	1.25	(2/)	(2/)
January 1935	1.70	1.25	(2/)	(2/)
July 1935	1.70	1.25	(2/)	(2/)
January 1936	1.70	1.25	$1.65	$2.00
July 1936	1.70	1.25	1.65	2.09
January 1937	1.70	1.25	1.65	2.00
July 1937	1.70	1.25	1.65	2.10
January 1938	1.90	1.25	1.65	2.10
July 1938	1.90	1.25	1.65	2.10
January 1939	1.90	1.25	1.65	2.10
July 1939	1.90	1.25	1.65	2.10
January 1940	1.90	1.25	1.65	2.10
July 1940	1.90	1.25	1.65	2.10
January 1941	1.90	1.25	1.65	2.10
July 1941	1.90	1.25	1.65	2.10
January 1942	3/1.90	3/1.25	3/1.65	3/2.10

1/ Compiled from Oil, Paint, and Drug Reporter.
2/ Not quoted.
3/ The market prices of technical grades are: Lithium bromide, $1.65; lithium carbonate, $0.95; lithium chloride, $1.25; lithium chloride (brine per pound of contained LiCl), $0.80; lithium fluoride, $1.90.

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LIST OF PRODUCERS, BUYERS, AND CONSUMERS

Lithium Producers, 1941

American Potash & Chemical Co., Trona, Calif.
Black Hills Keystone Corporation, Keystone, S. Dak.
Black Hills Tin Co., Tinton, S. Dak.
B. M. Dilley, Custer, S. Dak.
Lawrence Judson, Keystone, S. Dak.
Maywood Chemical Co., Keystone, S. Dak.
United Feldspar & Mineral Corporation, Kings Mountain, N. C.

Lithium-Ore Buyers

Associated Metals & Mineral Corporation, 40 Rector St., New York, N. Y.
Bergstrom Trading Co., Inc., Woolworth Bldg., New York, N. Y. (exporter).
Consolidated Feldspar Corporation, Trenton, N. J.
Corning-Glass Works, Corning, N. Y., (lepidolite).
Foote Mineral Co., 16th and Summer St., Philadelphia, Pa.
Harshaw Chemical Co., 1945 E. 97th St., Cleveland, Ohio.
E. J. Lavino & Co., 1528 Walnut St., Philadelphia, Pa.
Maywood Chemical Co., Maywood, N. J.
R. T. Vanderbilt Co., 230 Park Ave., New York, N. Y.
Varlacoid Chemical Co., 116 Broad St., New York, N. Y.

Consumers and Manufacturers

Abbott Laboratories, North Chicago, Ill.
American Fluoride Corporation, 151 W. 19th St., New York, N. Y.
Dow Chemical Co., 919 Jefferson Ave., Midland, Mich.
B. F. Drakenfeld & Co., 45 Park Place, New York, N. Y.
Foote Mineral Co., 16th and Summer Sts.,Philadelphia, Pa.
General Electric Co., Lamp Department, 1133 East 152 St., Cleveland, Ohio.
Harshaw Chemical Co., 1945 East 97th St., Cleveland, Ohio.
Lithaloys Corporation, 444 Madison Ave., New York, N. Y.
Mallinckrodt Chemical Works, Second and Mallinckrodt St., St. Louis, Mo.
Maywood Chemical Co., Maywood, N. J.
Vitro Manufacturing Co., Corliss Station, Pittsburgh, Pa.
Lithium Corporation of America, Raymond and Commerce Bldg., Newark, N. J
Metalloys Corporation, 730 Rand Tower, Minneapolis, Minn.

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